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LLNL-CONF-491665

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August 1, 2011

Frontiers of Electron Microscopy in Materials Science
Rohnert Park, CA, United States
September 18, 2011 through September 23, 2011

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The ability to probe the transient states of catalyst nanoparticles can provide an understanding of the mechanisms behind catalysis and lead to control and tailoring of particle/substrate interactions at elevated pressures and temperatures. This requires an *in-situ* characterization technique capable of imaging with both high spatial and temporal resolution. The dynamic transmission electron microscope (DTEM) provides this ability to study catalysis *in-situ* with nanometer spatial resolution and nanosecond time resolution [1,2], generating several orders of magnitude increase in spatio-temporal resolution over conventional video frame rates. The current DTEM uses electron pulses ~15 ns in duration for single-shot imaging of dynamic processes, which minimizes electron-beam interactions during dynamic studies. The next-generation DTEM will be capable of μs electron pulses that can provide atomic-scale spatial resolution for imaging.

The use of the DTEM to study supported nanoscale metal particles and clusters is focusing on the identification and control of active sites on catalyst nanoparticles, which are responsible for the selectivity of chemical reactions and nucleation of nanostructures. Gaseous environments that cannot be obtained in the electron microscope are achieved using *in-situ* gas stages that incorporate a windowed-cell design into the TEM holder for both the DTEM and an aberration-corrected scanning transmission electron microscope (STEM). The stage for the aberration-corrected STEM uses a continuous-wave laser built in to the holder for heating of the specimen while the DTEM uses a pulsed laser for ultrafast laser heating. This combination of *in-situ* DTEM and *in-situ* aberration-corrected TEM allows studies of catalytic reactions across multiple spatial and time scales.

Preliminary results on catalyst nanoparticles and clusters, along with aspects of the design, implementation, and characterization of the *in-situ* gas stages within the DTEM platform will be presented [3].

References

[1] W.E. King et al., *J. Appl. Phys.* 97 (2005) 111101-1.

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[3] The authors acknowledge work performed under the auspices of the U.S. Department of Energy, Office of Science, Office of Basic Energy Sciences, Division of Materials Sciences and Engineering, by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.